Future harm and current obligations: the case of global warming

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July 1993

Discussion
Paper in
Economics

93/11

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INTRODUCTION

The literature on global warming has been expanding rapidly over the last five years. Yet, little attention has been paid to the implications of going beyond a doubling of carbon dioxide. Concentrating our attention on the double CO_2 scenario shows a limited understanding of the available scientific information on global warming and a lack of concern for the future. In fact this suggests a time horizon of a around 30 years; as 2025 is the date by which such a doubling is to be expected according to the Intergovernmental Panel on Climate Change.

Such a position should not surprise economists who are used to invoking discount rates of 10% and calculating net present values. The point of view is only reinforced by the creation of an intergenerational externality which result in the asymmetry of costs and benefits; that is the imposition of costs and risks on the unborn. However, the implications of acting in this way are extremely serious for future generations. In addition, the results imply a particularly undesirable moral stance.

In this paper the long term picture of global climate change is painted. The result is argued to be in favour of inaction on the part of the current generation if 'suitable' discount rates are chosen. This choice is then seen as a moral decision which requires justification. Four possible arguments in favour of discounting are presented and criticised. This leaves an indeterminate concern over the well being of future individuals which is inadequately expressed under the cost-

benefit approach to global warming (Nordhaus, May and July 1991; Ayres and Walter, 1991). More importantly, the arguments for ignoring responsibilities for the future effects of global warming are shown to reveal a fundamental flaw in economic reasoning. Harm cannot be handled in the same way as good, and the deliberate imposition of harm on the defenceless is immoral. As a result an obligation for the control of global warming is argued to exist.

The next section investigates the physical impacts of the greenhouse effect with some suggested economic implications. This is followed by a brief outline of the arguements concernng the existence of obligations to future generations. As a result of accepting some obligations their general nature is argued to derive from two seperate concerns: equity and injury. This latter concern is then considered as a cause for compensation. However, the extent to which compensation can be regarded as adequate, in a moral sense, recompense for deliberately inflicted harm is questioned. As a result some of the issues surrounding a the rights of future generations are raised.

INTERTEMPORAL IMPACTS OF GLOBAL WARMING

Mean global temperature has in the past been much warmer than at present; 1°C during the Holocene climatic optimum (5000 to 6000 years ago), 2°C higher during the last interglacial warming (125,000 years ago), and 3°C to 4°C higher during the Pliocene (3 to 4 million years ago) (MacDonald, 1988). However, over the last 10,000 years, from the Holocene to the

Little Ice Age, the mean temperature of the northern hemisphere varied by no more than about 2°C (Gates, 1983). Given a mean global temperature, in recent years, of approximately 15°C the variation since the Holocene has been less than 14 percent.

The earth's mean surface temperature has increased between 0.5°C and 0.7°C, or 3 to 5 percent, since 1860 (Abrahamson 1989 p.10), coinciding with the increased combustion of fossil fuels due to industrialisation. Hansen et al. (1986) predict the warming of most mid-latitude northern hemisphere land areas at between 0.5°C to 1.0°C by 1990-2000, and 1°C to 2°C by 2010-2020. The evidence from more than 100 independent studies gives estimates of average global warming within the 1.5°C to 4.5°C range (up to a 30 percent increase) for a double carbon dioxide scenario (Jamieson, 1988). Such a doubling is expected sometime in the next century. Thus, global warming due to the release of greenhouse gases represents a potentially drastic temperature increase over a relatively short period of time.

Yet, there appears to be a time during which aggregate benefits from greenhouse gas emissions dominate costs. Most obviously, society benefits from the relatively cheap use of fossil fuels, but there are other benefits as well. An average global warming of 0.5°C is expected to produce net benefits in terms of heating, agriculture, and water use (d'Arge et al., 1975). Research suggests that Great Lakes fish may benefit; with Walleye yields in Lake Michigan increasing 29-33%, although trout may simultaneously decrease by 2-6%

(Mlot 1989). Idso (1983) maintains that increased levels of atmospheric CO_2 will increase future well-being via crop fertilization. This is achieved if escalated CO_2 concentrations enhance crop productivity, by increasing rates of photosynthesis, and reduce water use, by decreasing rates of transpiration. The projected yield increases range from 16%, for corn, to 60%, for cotton, under a CO_2 doubling (Seneft, 1990). In the past an argument has been put forward in favour of deliberately increasing mean global temperature to reap the benefits of delayed glaciation and increased agricultural range (Callendar 1938, p.236). More recently, a similar line of reasoning can be found in Crosson (1989) where the costs of stopping warming are to be weighed against the potential loss from doing so too soon.

Such benefits are often ignored and would of themselves imply serious economic impacts, e.g., on world trade. However, as temperature increases benefits are likely to diminish. The positive CO_2-fertilization effect will only prove beneficial while CO_2 remains a dominant gas in climate forcing. As other gases become relatively more important, this benefit will diminish while negative impacts of global warming on crop yields increase. Agriculture and, particularly, forestry are more susceptible to serious declines if climate change occurs rapidly. For example, in North America each 1°C rise in temperature translates into a range shift of about 100 to 150 kilometres (Roberts, 1989). The rate of northward dispersal of trees due to historical warming, shown by fossil records is 10 to 45 kilometres a century, with Spruce the fastest at 200

kilometres. Abrahamson (1989) estimates, given current gas emissions, global warming is proceeding at between 0.15°C and 0.5°C per decade. Thus, almost all forest species in North America will expand into colder northern climates at slower rates than their current range becomes uninhabitable. A similar problem may exist for agriculture, but no thorough analysis of adaptive capacity has yet been conducted for the agricultural sector (Parry, 1990).

Costs will also escalate as the ability to adapt is restricted by the absolute size and increasing rate of sea level rise. Studies suggest the rate of change of sea level will be relatively small in the first quarter of the next century compared to the last quarter, and this is true for a variety of underlying emissions scenarios (Titus 1989). The absolute rise is estimated at between two thirds of a meter to over three and a half meters by 2100 (Thomas 1986, Titus 1986, Titus 1989). Cost estimates for protecting against a one meter rise include $4.4 billion for the Netherlands (Goemans, 1986), and up to $100 billion for the east coast of the United States (Jaeger, 1989). Broadus (1986) provides an indication of the damages to unprotected nations from a one meter rise. These include the loss of around one tenth of the land area in both Bangladesh and Egypt, resulting in the dislocation of over 16 million people. Meanwhile, other expectations are that low lying islands, such as the Maldives, would disappear completely.

The intertemporal asymmetry of impacts is apparent as initial benefits to most regions, from slight global warming,

turn into very large economic costs, as warming continues. Population migration will undoubtedly occur as land is lost to rising seas and storm surges, and agricultural productivity is reduced in semi-arid regions. The more extreme and rapid the temperature increases the greater are the costs and the fewer are the benefits. Thus, not only will the damages of preceding generations' greenhouse gas releases be placed upon those in the distant future, but the cost of continuing to release those gases will escalate (d'Arge and Spash, 1991).

The majority of evidence concerning global warming limits itself to a double CO_2 scenario, and ignores what happens beyond that point. There is, as Crosson (1989) has noted, no reason to believe global warming will stop there. Some research has been carried out concerning what happens next. Past greenhouse gas emissions have created a stock in the atmosphere making some global warming irreversible. The lifetime of CO_2 in the atmosphere, biosphere, and upper ocean combined is approximately 500 years (Wuebbles, Grant, Connell and Penner, 1989). Emissions of greenhouse gases prior to 1985 have already committed the earth to a warming of 0.9°C to 2.4°C, of which about 0.5°C has been experienced. The warming yet to be experienced is unrealized warming, 0.3°C to 1.9°C, and is unavoidable (Ciborowski, 1989). Emissions of the principal greenhouse gases are increasing at rates between 0.3 and 5 percent per year (Wuebbles, Grant, Connell and Penner, 1989). Within 50 years we are likely to create an irreversible increase of 1.5°C to 5°C, and in the 40 years following that a further 1.5°C to 5°C increase (Ciborowski, 1989). As Cline

(1991) reports, a sixfold increase in CO_2 has been estimated by 2250 and an eightfold increase by 2275 associated with central estimates of 7.5°C and 10°C respectively. Beyond this point the role of ocean uptake is hoped to be our saviour with CO_2 levelling out at 3.5 times preindustrial levels in 750 years time (given that the system is not chaotic). The implication is of continually rising temperatures and associated damages for at least the next 250 years followed by 500 years of stabilization.

RESPONSIBILITIES TO FUTURE GENERATIONS

The previous section has suggested how the greenhouse effect could have serious impacts upon future generations while actually benefiting their predecessors. Economic decisions over what action, if any, to take concerning such intergenerational issues are essentially controlled by the social discount rate. Economists via their choice of discount rate are implicitly attributing different intertemporal weights to welfare.

The standard application of cost-benefit analysis to the greenhouse effect, even if all costs and benefits could be calculated, would give the impression that the future is almost valueless. As Nordhaus (July 1991 p.936) has stated,

> The efficient degree of control of GHGs would be essentially zero in the case of high costs, low damages, and high discounting; by contrast, in the case of no discounting and high damages, the efficient degree of control is close to one-third of GHG emissions.

The distribution of net costs in the future, and net benefits now, makes the emission of greenhouse gases appear falsely attractive. The process of discounting the future, at almost any positive rate, creates insignificant present values for even catastrophic losses in the further future. Quirk and Terasawa (1991) have recently argued in favour of a government discount rate of 10 percent or more. A 10 percent discount rate results in benefits and costs occurring in 50 years time to be weighted at less than 1 percent. That is, future values asymptotically tend to zero relatively quickly.[1]

The acceptance of discounting as the proper approach to intertemporal distribution requires an unavoidable moral judgement (Page 1977). Thus, strong supporters of discounting must have strong moral justifications for doing so. The rationale for discounting is that individuals express a positive time preference and capital is productive (Pearce, 1983). That is, both consumers, via a positive rate of time preference, and producers, via the social opportunity cost of capital, are observed to treat the future as less important than the present. Much debate then concerns the appropriate rate to chose, and the relationship between private and social time preference rates. The determination of a single rate is not of concern in this paper, but rather the underlying justification for the use of any particular rate (positive, zero, or negative).[2]

In general there are four reasons which could be advanced to justify giving less weight to the expected future damages of global warming than if they were to occur now.[3]

These concern who constitutes the electorate, uncertainty over future preferences, the extinction of the human race, and uncertainty over future events. Each is explained below along with some counter arguments.

First, taking into account the benefits to unborn generations of greenhouse gas abatement may be considered to widen the concept of democratic voting in an unacceptable way. That is, those who are alive today constitute the proper electorate and the government's social welfare function should reflect only the preferences of present individuals (Marglin 1963). An altruistic counter argument can be made in as far as individuals identify with a community extending over time. In this way posterity gains a voice and a kind of vote due to the influence of this voice on actual votes (Boulding, 1966 p.260). This vote while perhaps extending the concept of democracy is still quite limited.[4] A further extension is to accept certain rights for future individuals (discussed further below). The problem with ignoring future voters is that policy decisions are encouraged which impose costs upon them to benefit the present and may later have to be reversed. For instance, the construction of Hetch Hetchy dam adjacent to Yosemite valley, in California, flooded an area which is now highly valued in its former pristine state. In this case strong representations are being made to have the dam removed and attempt restoration. Unfortunately, once greenhouse gases are emitted they are almost entirely beyond our control, i.e. the action is irreversible (Spash and d'Arge, 1989).

If the vote of future generations over greenhouse gas

control is to be included, in some manner, the argument can be advanced that this is impossible since future preferences are unknown. This second argument claims that no coherent sense can be given to making persons better or worse off if the specific persons are not the same ex ante and ex post. This argument relies upon the assumption that all rights come from individuals and therefore the identity of individuals is central to their rights. Individuals cannot claim they have been harmed by global warming if they would otherwise not have existed.

However, we can recognise certain actions will harm future persons despite indeterminacy concerning their identities and our ignorance of their special needs. Whoever exists can reasonably be expected to have the same biological needs as those now existing. Regardless of who exists they will be better off without a rapidly warming and increasingly unstable climate. As Baier (1984) has argued the wrongs we can do a future person are usually restricted to injuries fixed before the identity of future persons are fixed. For example the destruction of the Maldavian's homeland and the dislocation of millions of people in Egypt and Bangladesh might qualify as such wrongs.

The third attempt at justifying intertemporal discrimination relies upon the inevitable extinction of the human race, for example see Heal (1986). As the human race will no longer exist the degradation due to global warming can be dismissed or at least discounted. Resources used for greenhouse gas control are then better used for increased

consumption for the immediate generation. However, the basis for such a policy is unclear, and has been countered by the ideas of the spaceship earth literature, where compensation of the future for increased degradation is required. Furthermore, this approach in the case of global warming is in line with a self-fulfilling expectation.

The fourth argument has some points in common with the extinction argument. In this case the uncertainty over the impacts of global warming are such that there is a probability no damages will occur and this probability might be increasing overtime. On moral grounds, this is equivalent to arguing that undertaking actions which can harm others is justified because there is a chance they will remain unharmed (Routley and Routley 1980). My loosening the wheels on your car is acceptable because you might not crash as a result. From an economic perspective, the argument means that when deciding to undertake an emissions abatement project the future should be discounted at some positive rate to account for the risks when calculating the present value of the investment. However, except under special circumstances, there is no well-defined way to adjust the discount rate such that it will make the appropriate adjustment for risk in the present value of uncertain future benefits and costs in each period. This is explained at length, in the context of energy related projects, by Lind (1982).

In addition, Fisher (1981) has shown how the type of uncertainty under consideration can result in either increased or decreased depletion rates for non-renewable resources. That

is, uncertainty can result in resources being preserved for the future rather than depleted faster. Thus, where assimilative capacity is being depleted, with uncertainty as to the stock, risk aversion would argue in favour of reducing the rate of depletion, eg, reducing the rate at which carbon dioxide is released and atmospheric capacity is mined.

None of the four justifications seem particularly valid or enlightening. They all appear to be, more or less, fall-back positions, and weak moral grounds from which to defend intergenerational discrimination in the form of discounting. Interestingly enough, only at the extreme of an infinite discount rate would no consideration be given to the future effects of greenhouse gas emissions. Cost-benefit analysis as commonly applied would use an arbitrary but positive rate. Thus, implicitly, some concern for the future effects of global warming would be shown, but the extent of this concern would depend upon the discount rate chosen. The problem which faces economists, falling back on the use of a morally unjustified positive rate, is that their policy conclusions have serious long term implications. As a result the more alert authors are forced to provide footnotes, caveats, and qualifications to the effect that some 'compensation' or intergenerational transfer may be necessary to correct for inequity (see for example Quirk and Terasawa 1991).

EQUITY AND INJURY

There is a persistent view that the current generation need not be concerned over the loss or injury caused to future

generations because they will benefit from advances in technology, investments in both man made and natural capital, and direct bequests. Adams (1989, p.1274) has raised this exact issue in terms of alleviating our responsibilities for global warming. While fossil fuel combustion implies foregone opportunities for future generations, they "typically benefit (in the form of higher material standards of living) from current investments in technology, capital stocks, and other infrastructure." This line of reasoning confuses actions taken for two separate reasons. That future generations may be better off has nothing to do with societies consciously deciding to compensate the future. That is, the standard or basic level of transfers carried out have been intended to leave the future better off on grounds of distributional justice. Upon realising the potential extent of global warming the current generation cannot claim basic or distributional transfers were really meant to be compensation for the consequences; the harm and loss to be inflicted.

If society has in fact been undertaking investments with the express purpose of compensating future generations for global warming the lack of publicity has been conspicuous by its absence. More importantly this would imply that the extent to which the future will be better off has in some sense been balanced against <u>all</u> the long term environmental problems. That is, society cannot take global warming and see the future as better off, and then ignore global warming and take ozone depletion as compensated, and then ignore ozone and balance nuclear waste against supposed future well being. Each case of

long term damages implies compensation.

Reducing the stocks of non-renewable resources affects future generations in a different manner from the creation of long term environmental damages. The concern in the case of resource depletion is for the maintenance of basic transfers. The concern in the case of environmental damages is for reparations for the violation of the right to remain unharmed. Those holding the view that the future is typically better off due to our actions imply that the goal of society has been to achieve ever increasing living standards. Thus, there has been an intention to improve welfare over time. Compensating individuals for the loss and harm they are to suffer has nothing to do with this undertaking.

If all things remain unchanged while non-renewable resources are depleted the future will have fewer options. That is, for a given technology and capital stock output will be lower and environmental degradation higher. Thus, compensation, via improved technology and increased capital investment, has been suggested (Barry, 1983). Compensation in this context concerns the maintenance of a basic opportunity set and is therefore properly regarded as welfare distribution. However, there is no particular reason to limit compensation for damages to welfare rules being used to determine distributional transfers. The appropriate reference point for compensation is the level of damages caused to an individual. The reference point for distributional transfers is the welfare level, difference in welfare, or opportunity set of others.

Two distinct types of transfer across generations are relevant in the context of global warming. First, there is a set of basic distributional transfers, which will be defined by the ethical rule used in a society, eg, Paretian, egalitarian, elitist. Basic transfers may be considered as achieving the ethically required basic welfare or living standard. Second, there are compensatory transfers, which are made because injury or loss is inflicted upon a later generation by the actions of the current generation, such as the combustion of fossil fuels.

The distinct nature of such compensatory transfers has been neglected. This has been partly because they are assumed to be identical to basic transfers, and partly due to the principle of "potential compensation". If the current greenhouse gas emitters could compensate the future climate change losers emissions are an improvement regardless of whether compensation is actually paid. If compensation were undertaken the principle is the Pareto Criterion.

This leads to an interesting paradox. According to Freeman (1986) the Pareto Criterion is neither widely accepted by economists nor plays any role in mainstream environmental economics. Yet, the basis of cost-benefit analysis is the potential compensation principle, which "... is justified on ethical grounds by observing that if the gains outweigh the losses, it would be possible for the gainers to compensate fully the losers with money payments and still themselves be better off with the policy" (Freeman, 1986). Thus, the justification for the results of cost-benefit analysis is that

they are potential Pareto improvements, but Pareto improvements themselves are rejected.

Thus, use is made of the potential compensation principle to deny compensation. The other reason for invoking the principle is to separate efficiency and equity. Discussions of actual compensation have been avoided on grounds that equity issues are outside of the economists realm.[6] The failure to distinguish compensation from basic transfers can be seen as a symptom of focusing on the one normative concept of efficiency.

Compensation can be defined as making amends for loss or injury; implicitly involving an asymmetry of loss and gain. The greenhouse effect as characterised earlier creates an asymmetric distribution of losses and gains over time. Intergenerational compensation would counterbalance the negative outcomes of global warming by positive transfers, while not interfering with basic transfers. For example, assuming egalitarianism the maintenance of the same welfare level fails to compensate for global warming. Yet the suggestion has been made that spreading the costs of global warming equitably across generations is an acceptable solution (Crosson, 1989).

The stumbling block here is in recognising that compensation for injury is a separate moral issue from the concern over distribution. Government transfer payments to the poor cannot be taken as allowing the government to inflict injury on the poor while claiming the transfers as compensation. Similarly, receiving unemployment benefit is

unconnected to a claim for damages when the government is responsible for negligence which, for example, paralyses an unemployed individual.

LIMITS TO COMPENSATION FOR GLOBAL WARMING

The extent to which compensating future generations for damages is acceptable is smaller than might be suggested by economists who view changes in units of welfare as equivalent regardless of their direction.[7] The standard approach of economists can be traced at least as far back as Bentham (1843 p.438):

> ...To the individual in question, an evil is reparable, and exactly repaired, when after having sustained the evil and received the compensation, it would be a matter of indifference whether to receive the like evil, coupled with the like compensation, or not.

Unfortunately, this approach treats harm as reversible by good. In general, doing harm is not cancelled out by doing good. If an individual pays to have a road straightened and saves two lives a year, they cannot shoot one motorist a year and simply calculate an improvement (Barry, 1983). This argument is most apparent where the right to life is involved, but can be extended to other areas where rights are accepted to exist. For example, assume individuals of a nation are accepted to have a right to live in their own homeland. Sea level rise due to global warming floods the Maldives and violates this right. Of course the Maldavians can be relocated

and compensated, but this approach is unacceptable given the previously stated right.

The objection free-market economists might raise to the imposition of such rights is that freely contracting parties are prevented from entering into agreements of their own free will. As Bentham went on to point out:

> What is manifest is --- that to no person, other than the individual himself, can it be known whether, in this instance, between an evil sustained, and a benefit received on account of it, any compensation have place or not.

That is, the individual is their own best judge of welfare changes. If the Maldavians believe they are better off in their new homeland then who is to deny the acceptability of this exchange. The difficulty in the intergenerational context is that the individuals who will be impacted are unavailable for comment. In order to protect these individuals from unjustified harm rights could be used, so that what appeared to be a problem for the use of rights can be viewed as an argument in their favour.

The appeal to the "safe minimum standard" can be viewed as an example of constraining economic trade offs by introducing rights. This standard advocates the protection of species, habitats, and ecosystems unless the costs of doing so are "unacceptably large". In the case of global warming Batie and Shugart (1989) argue that the safe minimum standard would support emission reductions despite apparently high costs. However, the withdrawal of the right of say a species to exist

at some cost implies a basis of the right within utilitarian morality. This view contrasts with rights in the context of a deontological philosophy.[5]

More generally, the economic process of exchange can be viewed as the transfer of goods and services within a framework of established rights. In this case rights are only valid in as far as the institutional setting allows them to exist. This position was expounded by Bentham (for a more recent argument along these lines see Bromley, 1991). Yet the question being probed here is one of the existence of a right of future generations in the sense of a natural right, not merely the recognition by a piece of legislation in a particular society that such a right is valid.

There are many instances where intrinsic human values are recognised by "free-market economies" and such rights are protected from violation by contractual agreement. For example, the right to freedom of speech, to freedom from torture, to sue another party, to be free from slavery. Freely contracting children are protected from working in coal mines despite the potential economic gains. These rights are maintained despite the fact that there are those who would accept the loss of their rights given enough money, or societies in which these rights are denied.

The question is, given that they will exist, do future generations have inalienable rights? The UN charter of human rights represents an internationally accepted set of goals to which the world aspires. The fact that these rights are violated does not reduce their importance. Yet within these

rules there is little comfort for future generations. A generous reading would only protect the future indirectly under articles intended to protect the current generation. Public concern is starting to be expressed regarding this oversight and this has reached the extent of a global petition to the United Nations.[9]

If rights which protect future individuals from the results of our greenhouse gas emissions are accepted to exist the scope for trade-offs commonly assumed in economics will be drastically reduced. Compensation payments are no longer licences for society to pollute, provided the damages created are less than the amount of compensation. In which case compensation cannot be used to excuse the continuation of greenhouse gas emissions. Irreversible damages which will occur regardless of greenhouse gas emissions reductions would require compensation. In order to protect the future from potential infringements upon this right actions with uncertain intertemporal consequences would have to be avoided, and environmentally benign production and consumption processes encouraged.

Stopping the build up of greenhouse gas emissions in the stratosphere is complicated by the delay in transportation. That is, concentrations would continue to increase for over one hundred years. For example in the case of chloroflurocarbons total emissions in the world would have to be reduced by approximately 85 percent immediately in order to stabilize the concentration of CFC12 (Hoffman 1986). Due to the cost of enforcing the rights of future generations to

remain unharmed the current generation has a vested interest in denying those rights. Continuing to emit greenhouse gases at current rates denies the future the right to remain undamaged and asserts the dominance of the current generation. The current generation is then being asked to change the present rights structure, as found within society, in a manner detrimental to its own interest. The dictatorship of the current generation allows the imposition of damages regardless of the gain now and the extent of future damages. Yet, the abolition of slavery is an example of just such a change within society.

The economists' appeal to cost-benefit analysis attempts to take losses and gains of controlling harmful activities directly into account. In doing so the rights of future generations are violated when the costs of controlling the greenhouse effect are deemed to exceed the benefits of that control. The use of cost-benefit analysis therefore denies the existence of inalienable rights. Reliance upon the potential compensation principle prevents compensation while the welfare of a subgroup of individuals is reduced. Even the Pareto criterion allows harm to be inflicted but at least this harm must then be compensated for by resource reallocation. That is, harm and good are seen as equivalent. However, harm is recognisably different from good and the deliberate infliction of harm is morally objectionable. If the right to remain unharmed is given to future individuals actual compensation is required if these rights are violated. If at all possible these rights should not be violated and people should be freed

from actions which deliberately externalise the risk of damages by imposing it upon others. This can be viewed as a stricter definition of the Pareto criterion preventing harm rather than allowing harm and actual compensation.

CONCLUSIONS

The slippery slope of externalising the harm created by our actions can be viewed as having led us to the dramatic risks of damages faced by the world under global warming. Whether this issue materialises in the devastating form some predict or not the moral implications go to the heart of the modern industrial society. Immoral actions can be justified if society or individuals can potentially (but not actually) transfer resources to those harmed. Of course, hopefully the consequences of such actions will be felt by those on the other side of the world and living in the distant future so even the potential need for such considerations can be discounted. Restricting the current global warming debate to a double-CO_2 world is endemic of how closed our minds are to the potential results of our actions.

If the current individuals are concerned for the damages caused to future individuals the nature of the obligations which may exist must be analysed. Those obligations extend beyond potential compensation and even beyond actual compensation. Thus, climate change can be viewed as the deliberate creation of harm which the current generation cannot ameliorate with promised welfare increases. This implies a much stricter greenhouse gas reductions programme

than most of the current economics literature argues is justified. The exact degree of strictness will depend upon the way in which we define our obligations to the future.

Endnotes

1. Recognising the potential for such discrimination against future generations Quirk and Terasawa do suggest compensation for any costs imposed to be achieved by "investment set-asides".

2. The bizarre nature of an individual (or society) holding a negative rate of time preference lies in the implication that all consumption will be delayed until tomorrow. Costs and benefits occurring in the future gain more and more weight. Thus, even small future damages are likely to be avoided completely due to the weight they would have in current terms. Yet, some behaviour suggest societies have held negative rates eg. the Russians under Stalin, and that individuals do hold such marginal rates of time preference, see Loewenstein G. and Thaler, R. "Anomalies: Intertemporal Choice", Journal of Economic Perspectives, 3, no.4 (Fall 1989):181-193.

3. These justifications can be found in several sources for example Turner, 1988; Attfield, 1983; Kavka, 1978.

4. The concept of a vote for all generations might be considered from the perspective of the original position

behind a veil of ignorance, as advanced by John Rawls.

5. This is much the same problem as an individual faces in allocating consumption over their lifetime.

6. For a contrary view see Page (1988).

7. The standard formulation of objective functions in economics makes the relative merits of social states depend upon the welfare characteristics of those states. Intergenerational efficiency allows for the violation of human rights because any two states which generate the same welfare values must be treated in exactly the same way. Even if a future generation is richer, enjoys a higher welfare level, and its marginal utility from a consumption gain is less than the marginal welfare loss of the present generation, intergenerational transfers may be required to avoid uncompensated long term effects of pollution (Sen, 1982).

8. A deontological philosophy sees certain features in a moral act itself as having intrinsic value. This viewpoint contrasts with teleological systems which see the ultimate criterion of morality in some nonmoral value that results from actions. For example, lying is wrong regardless of the consequences. See Pojman (1989). Neo-classical economist operate with a teleological outlook but there may exist a considerable number of individuals who hold to deontological philosophies. For example the refusal to play and extreme bidding found in

contingent valuation studies may be symptomatic of this.

9. See "Protecting the Rights of Future Generations" Calypso Log August 1991.

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